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AUTHOR Carnegie, John W.
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ABSTRACT

The rise time test (along with the settleometer procedure) is used to monitor sludge behavior in the secondary clarifier of an activated sludge system. The test monitors the effect of the nitrification/denitrification process and aids the operator in determining optimum clarifier sludge detention time and, to some extent, optimum degree of oxidation in the aeration basin. Designed for individuals who have completed National Pollutant Discharge Elimination System (NPDES) level 1 laboratory training skills, this module provides waste water treatment plant operators with the basic skills and information needed to: (1) run and evaluate the test for sludge rise time; (2) record data; and (3) describe how nitrification/denitrification affects sludge rise time. The instructor's manual contains a statement of instructional goals, lists of instructor/student activities and instructional materials, and student worksheet (with answers). The student workbook contains objectives, prerequisite skills needed before the module is started, laboratory procedures, and worksheet. (Author/JN)

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Operational Control Tests
for Wastewater Treatment Facilities

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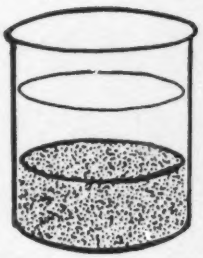
Rise Time

Instructor's Manual



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Linn-Benton Community College
Albany, Oregon

RISE TIME

Written By:
John W. Carnegie, Ph.D.
Linn-Benton Community College
Albany, Oregon

Instructional Design:
Priscilla Hardin
Corvallis, Oregon

Project Management:
John W. Carnegie, Ph.D.
Linn-Benton Community College
Albany, Oregon

Project Officer:
Lynn S. Marshall
United States Environmental Protection Agency
National Training and Operational Technology Center
Cincinnati, Ohio

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RISE TIME

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INSTRUCTIONAL GOALS

Upon completion of this lesson the student should be able to successfully run rise time tests and record the data. The student should also be able to describe how nitrification/denitrification affects sludge rise time. Use this lesson in conjunction with the lesson on the settleometer.

INSTRUCTOR ACTIVITY

For best results, follow this sequence:

	Activity	Time
1.	Review the objectives with the students.	2 minutes
2.	Have the students read through the procedure and supplementary material.	10 minutes
3.	Lecture/discussion on procedure.	10 minutes
4.	Demonstrate settleometer equipment. (Show selected slides from settleometer lesson if available.)	10 minutes
5.	Assign worksheet.	5 minutes
6.	Correct worksheet.	3 minutes

Other Activities:

1) If sludge samples are available, set up a settleometer in advance to demonstrate what a sludge sample looks like after rising.

2) If students are capable, discuss chemistry of nitrification/denitrification.

STUDENT ACTIVITIES

1. Read objectives.
2. Read procedure and supplementary material.
3. Listen to lecture/demonstration.
4. Complete worksheet.

INSTRUCTIONAL MATERIALS LIST

1. Instructor's Guide for Rise Time.
2. Student Workbook for Rise Time.
3. 35 mm projector and screen (if using settleometer slides).
4. Settleometer equipment for demonstration.
5. Sludge sample.

REFERENCE LIST

"Handbook of Advanced Wastewater Treatment", 2nd Edition, Culp, Wesner, and Culp, VanNostrand-Reinhold, 1978, Chapter 7.

"Chemistry for Environmental Engineering", 3rd Edition, Sawyer and McCarty, McGraw-Hill, 1978.

RISE TIME

WORKSHEET

Directions: Place an "X" by the best answer(s). There may be more than one correct response.

1. Microorganisms in mixed liquor convert ammonia to nitrite and then to nitrate by a process called:

   a)____ fermentation.

   b)____ denitrification.

   c)__X__ nitrification.

   d)____ fertilization.

   e)____ clarification.

2. Denitrification:

   a)____ is an aerobic process.

   b)__X__ is an anaerobic process.

   c)__X__ is a reduction process.

   d)____ is an oxidation process.

3. Rising sludge in a secondary clarifier:

   a)____ is always a hydraulic problem.

   b)__X__ could be caused by trapped nitrogen gas.

   c)__X__ contributes to poor effluent.

   d)____ means sludge detention time is too short.

4. To run a rise time test:

a)_____ it is best to start over after running the settleometer test.

b)_____ put settled sludge in a beaker and gently bubble air in under the blanket.

c)_____ measure the volume of the blanket after it expands.

d)__X__ continue observing settled sludge until it rises.

5. The rise time for settled activated sludge:

a)__X__ could be as short as one hour.

b)__X__ could be as long as six hours.

c)__X__ could be longer than eight hours.

d)_____ is always 3 - 6 hours.

Operational Control Tests

for Wastewater Treatment Facilities

Rise Time

Student Workbook

SE039209

Linn-Benton Community College
Albany, Oregon

RISE TIME

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John W. Carnegie, Ph.D.
Linn-Benton Community College
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Priscilla Hardin
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RISE TIME

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INTRODUCTION

This lesson on rise time is intended to be used in conjunction with the module on the settleometer. It is presented separately to emphasize the unique value of the test. The lesson is intended to give the operator the skills to run and evaluate the test for sludge rise time.

OBJECTIVES

Upon completion of this module you should be able to:

1. Describe the purpose of the rise time test.
2. Describe the test procedure.
3. Perform the test procedure.

PREREQUISITE SKILLS

This module is intended to be used by individuals who have completed the NPDES Level I laboratory skills training. In addition, you should be familiar with the settleometer procedure and the prerequisite skills listed with that module.

RESOURCE LIST

Settleometers may be purchased from:

1. Arthur H. Thomas Co.
   Vine Street at 3rd
   P.O. Box 779
   Philadelphia, PA 19105

   Nalgene Settleometer
   and Centrifuge Kit
   #9857-V25

2. SGA Scientific, Inc.
   735 Broad Street
   Bloomfield, NJ 07003

   J S - 1035
   Settleometer
   2 liter
   Double grad.

RISE TIME

INTRODUCTION

The microorganisms in the activated sludge process that help form the floc in mixed liquor are mostly aerobic and facultative organisms. In the aeration basin where oxygen is plentiful, they metabolize aerobically. Under certain aerobic conditions, ammonia is oxidized to nitrite and then to nitrate by the microorganisms. This process is called nitrification. When the mixed liquor enters the secondary clarifier it settles in an oxygen deficient environment. Under these anaerobic conditions facultative microorganisms reduce the nitrate formed earlier to nitrite and then to nitrogen gas. This process is called denitrification.

Nitrogen gas released during denitrification can become trapped in the settling floc and cause it to float to the surface degrading effluent quality. Mixed liquor in a settleometer will also denitrify and eventually the settled blanket in the settleometer will rise to the top. The time at which this occurs gives an estimate of nitrification/denitrification activity and how long sludge can safely be detained in the clarifier.

EQUIPMENT

Settleometer - 2 liter Mallory Direct Reading SGA Scientific, Inc. Catalog #JS-1035, or Nalgene Catalog #1010.

Stirring paddle

Timer (Electric Gralab, Model 500 or equivalent)

PROCEDURE

1. RUN SETTLEOMETER TEST.

   Refer to the lesson on settleometer tests. Collect sample and observe settling as indicated. Do not discard sample after observing settling.

2. CONTINUE TIMING.

   Continue timing the settling from the original zero time for the settleometer test.

3. OBSERVE SLUDGE BLANKET.

   Watch for the blanket to rise to the surface or flip over and float to the top.

4. RECORD RISE TIME.

Record rise time on settleometer data sheet. The rise time may take only one hour or it may not rise in eight hours or more. Typically, rise times are 3 - 6 hours.

5. DISCARD SAMPLE AND CLEAN SETTLEOMETER.

INTERPRETATION

The rise time test, along with the normal settleometer procedure, is used to monitor sludge behavior in the secondary clarifier of an activated sludge system. The rise time test specifically can monitor the effect of the nitrification/denitrification process and can aid the operator in determining optimum clarifier sludge detention time and, to some extent, optimum degree of oxidation in the aeration basin.

Nitrification occurs in the aeration basin and results in the formation of nitrates in the sludge going to the secondary clarifier. Nitrification occurs in all plants to some degree. Any plant having ammonia nitrogen levels of 2.5 mg/l or higher in the raw influent can expect significant nitrification if conditions are appropriate. The temperature, pH, and dissolved oxygen level in the aeration basin all influence nitrification. The warmer the activated sludge, the more nitrification will occur. Optimum pH for nitrification is about 8.5. Twice as much nitrification can be expected at a D.O. of 2.0 mg/l as would occur at a D.O. of 0.5 mg/l.

The anaerobic denitrification process occurs in the clarifier sludge blanket as the sludge loses its D.O. and becomes anaerobic. As the sludge becomes anaerobic the nitrogen gas released during denitrification is trapped in the sludge particles causing the sludge to rise to the top in clumps and deteriorating effluent quality. How quickly this occurs depends on the D.O. content of the sludge and the degree of nitrification that took place in the aeration basin.

The rise time test measures how quickly the sludge can be expected to rise. Rise times might vary from one hour to six hours. Some sludges may never rise. Normally oxidized, domestic sewage could be expected to rise in three to four hours.

The operator should calculate the sludge detention time for the secondary clarifier and compare that to the rise time. If the rise time is less than the detention time, rising sludge problems can be expected. Sludge detention time should be decreased by removing sludge from the clarifier faster. Nitrification can also be influenced by adjusting D.O. in the aeration basin. However, be cautious of upsetting otherwise good quality sludge production.

SUPPLEMENTARY MATERIAL

SETTLEOMETER TEST

INTRODUCTION

The purpose of the settleometer test is to indicate the solids-liquid separation capability of the sludge. The test is commonly used to make this determination on activated sludge entering the secondary clarifier and aerobic digesters, to determine downtime of the sludge.

EQUIPMENT

Settleometer - 2 liter Mallory Direct Reading SGA Scientific, Inc. Catalog #JS-1035 or Nalgene Catalog #1010

Stirring paddle

Timer (Electric Gralab, Model 500 or equivalent)

PROCEDURE

1. COLLECT SAMPLE.

   Collect at least 2.5 liters of sample and deliver to the lab within 15 minutes.

2. MIX SAMPLE.

   After the sample has been collected, it should be thoroughly but gently mixed and poured into the settleometer without delay.

3. POUR SAMPLE INTO SETTLEOMETER.

   Fill the settleometer to the 1000 cc mark. Although the settleometer actually holds 2 liters, it is calibrated from 0 - 1000 cc.

4. STIR SAMPLE.

   Slowly stir the sample in the settleometer with a paddle to insure that it is completely mixed. Then, use the paddle to stop the swirling motion of the liquid, slowly and carefully remove the paddle and start timing.
   Pieces of plexaglass the appropriate length make excellent stirring paddles. These pieces should be slightly less in width than the inside diameter of the settleometer.

5. READ SETTLEOMETER.

For Activated Sludge

After 5 minutes have elapsed, read the sludge blanket level (the interface between the solids and the clear liquid above the solids) in cc/l and record this reading. Read at five-minute intervals until 30 minutes have elapsed. During the next 30 minutes, read at 10 minute intervals.

Readings would be made at 5, 10, 15, 20, 25, 30, 40, 50, and 60 minutes. The sludge blanket level readings taken at these times are readings of the volume of settled sludge in cc/l.

6. RECORD DATA.

Record values of data, appearance of supernatant, appearance of sludge and of the sludge supernatant interface.

For Aerobic Digesters

Read and record the sludge blanket level in cc/l after 15 minutes, 30 minutes, and 1 hour, then once per hour until the sludge reaches ultimate compaction or rises. Determine the time and level of ultimate compaction and then the rise time of the sludge.

7. WASH SETTLEOMETER.

After the last reading has been taken, the settleometer should be washed with soapy water, rinsed with tap water, and dried with a towel or allowed to drip dry.

SETTLEOMETER DATA

Activated Sludge

Date	
Sample location	
Analyst	
Time of Test	
$SSC = \frac{(ATC)\ (1000)}{SSV}$	

Time	SSV cc/l	SSC %
0	1000	
5		
10		
15		
20		
25		
30		
40		
50		
60		

Observations:

Floc

[ ] flocculant

[ ] dispersed

Interface

[ ] well defined

[ ] ragged

Supernatant

[ ] clear

[ ] turbid

[ ] pin floc

[ ] straggler floc

Comments: (odor, color, etc.)

Rise Time_____ hrs.

Date	
Sample location	
Analyst	
Time of Test	
$SSC + \frac{(ATC)\ (1000)}{SSV}$	

Time	SSV cc/l	SSC %
0	1000	
5		
10		
15		
20		
25		
30		
40		
50		
60		

Observations:

Floc

[ ] flocculant

[ ] dispersed

Interface

[ ] well defined

[ ] ragged

Supernatant

[ ] clear

[ ] turbid

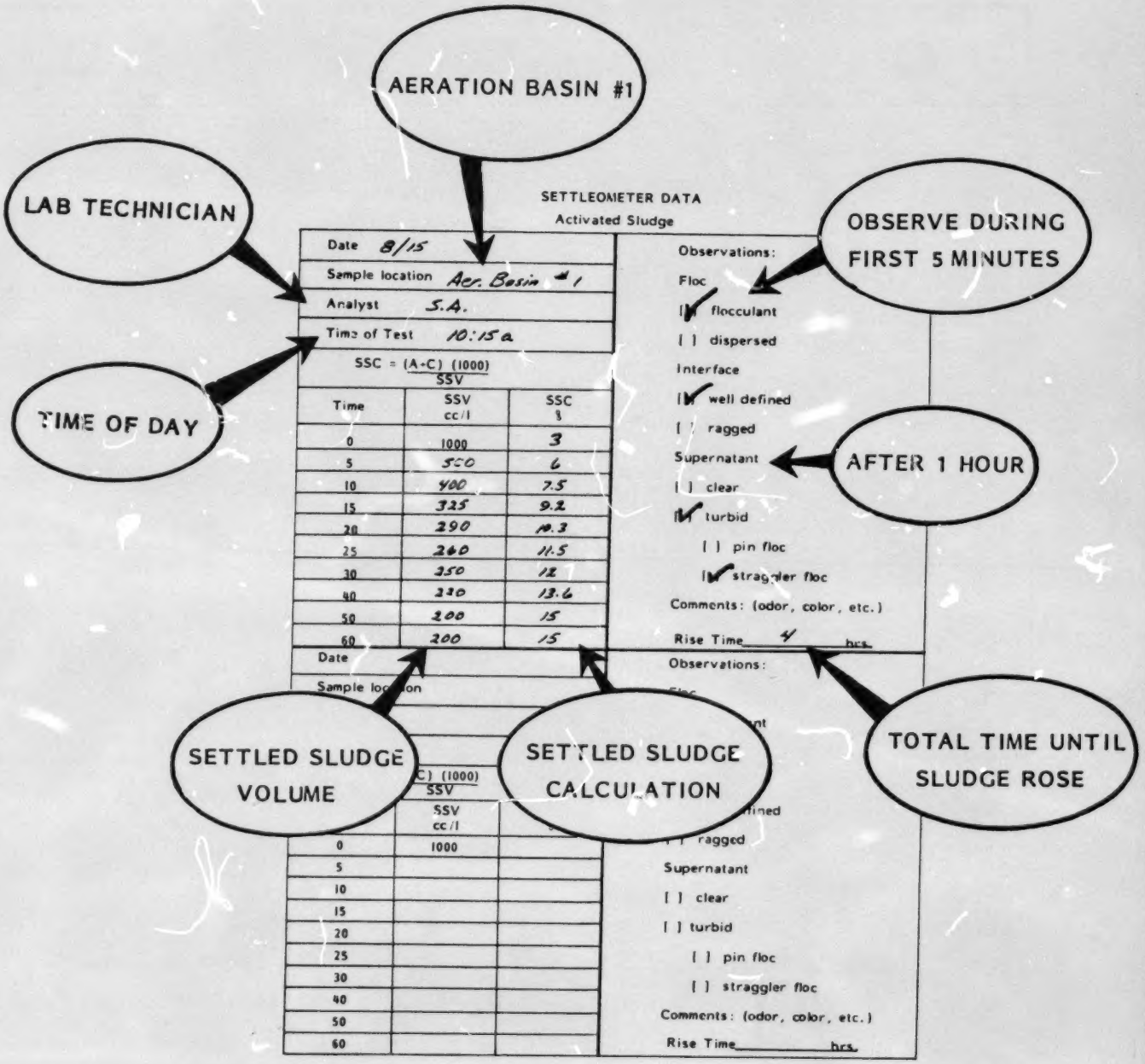
[ ] pin floc

[ ] straggler floc

Comments: (odor, color, etc.)

Rise Time_____ hrs.

SAMPLE DATA SHEET



SETTLEOMETER DATA
Activated Sludge

Date 8/15
Sample location Aer. Basin #1
Analyst S.A.
Time of Test 10:15a

SSC = $\frac{(A-C)\ (1000)}{SSV}$

Time	SSV cc/l	SSC %
0	1000	3
5	500	6
10	400	7.5
15	325	9.2
20	290	10.3
25	260	11.5
30	250	12
40	220	13.6
50	200	15
60	200	15

Observations:
Floc
[✓] flocculant
[ ] dispersed
Interface
[✓] well defined
[ ] ragged
Supernatant
[ ] clear
[✓] turbid
[ ] pin floc
[✓] straggler floc
Comments: (odor, color, etc.)
Rise Time 4 hrs.

Date
Sample location

0	1000	
5		
10		
15		
20		
25		
30		
40		
50		
60		

Observations:
Supernatant
[ ] clear
[ ] turbid
[ ] pin floc
[ ] straggler floc
Comments: (odor, color, etc.)
Rise Time_____ hrs.

PROCEDURE SUMMARY

PROCEDURE

1. Collect 2.5 liters sample
2. Deliver to lab within 15 min.
3. Mix sample
4. Pour 2 liters into settleometer
5. Stir
6. Stop motion of sludge

ACTIVATED SLUDGE

1. Read every 5 minutes for first 30 minutes and every 10 minutes for next 30 minutes.
2. Read rise time.

AEROBIC DIGESTOR

1. Read at 15 and 30 minutes
2. Read rise time

Settleometer

The above procedure summary is designed as a laboratory aid. It may be cut out and attached to a 5" X 7" index card for convenient reference at the laboratory bench. To protect the card you may wish to cover it, front and back, with clear, self-adhesive shelf paper or similar clear material.

RISE TIME

WORKSHEET

Directions: Place an "X" by the best answer(s). There may be more than one correct response.

1. Microorganisms in mixed liquor convert ammonia to nitrite and then to nitrate by a process called:

   a)_____ fermentation.

   b)_____ denitrification.

   c)_____ nitrification.

   d)_____ fertilization.

   e)_____ clarification.

2. Denitrification:

   a)_____ is an aerobic process.

   b)_____ is an anaerobic process.

   c)_____ is a reduction process.

   d)_____ is an oxidation process.

3. Rising sludge in a secondary clarifier:

   a)_____ is always a hydraulic problem.

   b)_____ could be caused by trapped nitrogen gas.

   c)_____ contributes to poor effluent.

   d)_____ means sludge detention time is too short.

4. To run a rise time test:

   a)_____ it is best to start over after running the settleometer test.

   b)_____ put settled sludge in a beaker and gently bubble air in under the blanket.

   c)_____ measure the volume of the blanket after it expands.

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